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(54) AIRED TIRE

(11) 60-193704 (A)

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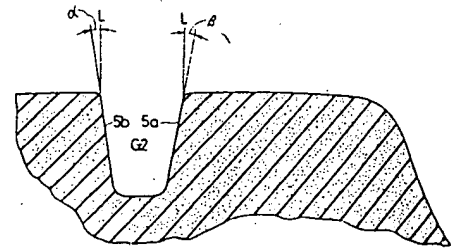
(22) 15.3.1984

(71) SUMITOMO GOMU KOGYO K.K. (72) SHIGEAKI TAKIGAWA

(51) Int. Cl. B60C11/06

PURPOSE: To improve the drainage performance, steering stability and gripping performance when cornering by making the inclination angle of the sidewall of an elongated groove in a tire tread face larger at the outside in longitudinal direction of tire than at the inside.

CONSTITUTION: The angle β to be made by the sidewall 5a at the outside in the longitudinal direction of tire of the longitudinal grooves G1, G2 arranged in the circumferential direction in the surface of tire tread is made larger than the angle α of the inside sidewall 5b where the angle β is set to 10~30°. With such arrangement, the rigidity at the tread section is improved while the deformation of the longitudinal groove is reduced resultin in the improvement of the steering stability, the drainage performance and the abrasion-resistance.



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⑭ 発明の名称 空気入りタイヤ

⑯ 特 願 昭59-50505

⑰ 出 願 昭59(1984)3月15日

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明 細 書

1. 発 明 の 名 称

空気入りタイヤ

2. 特 許 請 求 の 範 囲

(1)トレッド表面にタイヤ周方向に連続する複数の縦溝を有し、該縦溝のうちの少なくとも1つの縦溝はその断面形状においてタイヤ軸方向外側の側壁のタイヤトレッド表面の法線に対する角度(θ)はタイヤ軸方向内側の側壁のタイヤトレッド表面の法線に対する角度(φ)よりも大きく非対称溝で形成されており、しかも前記タイヤ軸方向外側の側壁の前記角度(θ)は 10°～30° の範囲であることを特徴とする空気入りタイヤ。

(2)縦溝のタイヤ軸方向内側の側壁のタイヤトレッド表面の法線に対する角度(φ)は0～5°の範囲である特許請求の範囲第1項記載の空気入りタイヤ。

3. 発 明 の 詳 細 な 説 明

本発明はタイヤトレッド面の縦溝の側壁の傾斜角度をタイヤ軸方向内側よりもタイヤ軸方向

外側で大きくすることにより、コーナリング時の排水性、操縦安定性、グリップ性を改善した空気入りタイヤに関する。

一般にタイヤのトレッド面は、湿潤路面の排水性、グリップ性を改善するためタイヤ周周方向に連なる複数の縦溝が配設される。排水性を改善する観点からは縦溝の幅及び深さ及び溝数を増加することが効果的であるといえる。しかし、縦溝の幅等を増加するとトレッド部のいわゆる海/陸比の値が大きくなりトレッド部の滑性が低下し、操縦安定性、耐摩耗性が低下することとなり、前者の特性は後者の特性と二律背反する関係となる。そこで従来からこれらの特性のバランスを考慮してトレッド面の溝形状の設計がなされており、溝幅、溝深さ及び溝数はおのずと一定の範囲に限られることとなる。そして縦溝の断面形状は偏摩耗防止あるいは美的外観の観点から溝の側壁が相互に対称となるように形成されている。このような従来の溝の設計技術では、排水性と操縦安定性、耐摩耗性を同時に向上することが困難である。

そこで本発明者は上記問題点を解決するため、タイヤ走行時のトレッド面の変形挙動をモデル化し、溝の断面形状とその変形状態の関係を詳細に検討し、かかる知見に基づき溝の断面形状を最適化することにより排水性を犠牲にすることなく、操縦安定性、耐摩耗性の向上を達成し得たのである。

本発明はトレッド表面にタイヤ周方向に連続する複数の縦溝を有し、該縦溝のうちの少なくとも1つの縦溝はその断面形状においてタイヤ軸方向外側の側壁のタイヤトレッド表面の法線に対する角度 ϕ はタイヤ軸方向内側の側壁のタイヤ表面の法線に対する角度 ψ よりも大きく非対称溝で形成されており、しかも前記タイヤ軸方向外側の側壁の前記角度 ϕ は $10 \sim 30^\circ$ の範囲であることを特徴とする空気入りタイヤである。

以下図面にしたがって本発明の実施例を説明する。第1図は本発明のラジアル構造の空気入りタイヤの概略断面図の右半分、第2図は第1図の縦溝の拡大図である。第1図においてX-Xはタイ

ヤ軸と平行な線Y-Yはタイヤ赤道面である。

本発明の空気入りタイヤ(1)は一對のビードコア(2)とそのまわりを内側から外側にかけて折り返されるカーカス(3)と、このカーカスのクラウン部外側に配設されるベルト層(4)を有している。そしてタイヤトレッド表面にタイヤ周方向に連続する2本の縦溝(G1, G2)が配設されている。そして1つの縦溝(G2)の側壁(5a, 5b)はタイヤトレッド表面の法線①に対してそれぞれ所定の角度(α , β)を形成するように傾斜している。ここでタイヤ軸方向外側の側壁(5a)の角度 ϕ はタイヤ軸方向内側の側壁(5b)の角度 ψ よりも大きく傾斜する非対称溝である。ここで側壁(5a, 5b)はいずれもタイヤ周方向にほぼ一定の傾斜で形成されているが、タイヤ円周方向に傾斜角度が変化するよう形成することもできる。そしてタイヤ軸方向外側の側壁の前記角度 ϕ は $10 \sim 30^\circ$ の範囲に設定される。縦溝の断面形状を上述の如く形成することによりタイヤ走行時のトレッド部剛性が向上し、そのため縦溝の変形量が軽減でき、安

定した縦溝容積が維持され、排水性が保持されるとともに操縦安定性も一層向上する。このことはタイヤ走行時のトレッド面の変形挙動をモデル化し溝の断面形状とその変形状態の関係から確認できた。つまり第3図においてタイヤTはp方向に走行しながら左方向(PL方向)にコーナリングする際、タイヤの右半分(斜線部分)のトレッド部はf方向の変形を受けることとなる。これをトレッド部の右半分断面図を示す第4図において説明すると無荷重状態のトレッド表面輪郭線(OL)はコーナリング時においては変形し、縦溝(Ga, Gb)の溝幅は大きく狭められることとなり、それに伴い接地特性が低下することとなる。例えばコーナリング時縦溝(Ga)の溝幅は(W1)から(W2)に減少するように変形するため縦溝の容積が減少し排水性が低下することとなる。そこで縦溝の溝幅の変化量をできるだけ減少することが好ましいがこの溝幅の変化量と縦溝の側壁角度の関係を検討したところ溝幅の変化量は縦溝のタイヤ軸方向外側の側壁角度 ϕ の増加とともに小さくなること、

更にタイヤ軸方向内側の側壁(Ga1)はタイヤ軸方向外側の側壁(Ga2)よりもその変形量の側壁角度に対する寄与率が小さいことが判明した。

例えば第5図及び第6図に示すトレッド部にf方向の力が作用した場合の縦溝(GA, GB)のそれぞれの両側壁はその傾斜角度の違いによって第1表の如く変形量は異なってくる。第5図において α_1 , α_2 は5度、 β_1 , β_2 は30度また第6図において α_1 , α_2 は5度、 β_1 , β_2 は30度である。故からタイヤ軸方向内側の側壁よりも外側の側壁を大きくすることにより溝幅の減少が大幅に軽減できることが認められる。

第1表

		対称溝(第5図)		非対称溝(第6図)	
		GA	GB	GC	GD
側壁の変形量	①	0.77	0.84	0.71	0.82
	②	1.86	1.86	1.46	1.46
溝幅の減少量	①	1.09	1.02	0.75	0.64
	②				

ここで縦溝の傾斜角度を大きくするとトレッド部の接地面積が減少し縦溝による排水効果及び耐摩耗性が低下するため、その傾斜角度にはおのずと限界がある。本発明ではタイヤ軸方向内側の側壁(5b)(6b)のタイヤトレッド表面の法線に対する角度(α_1)(α_2)は $0^\circ \sim 5^\circ$ の範囲で、一方タイヤ軸方向外側の側壁(5a)(6a)のタイヤトレッド表面の法線に対する角度(β_1)(β_2)は $10^\circ \sim 30^\circ$ の範囲に設定され、またタイヤ軸方向内側の側壁の角度(α)とタイヤ軸方向外側の側壁の角度(β)の差は $5^\circ \sim 20^\circ$ の範囲に設定されることが好適である。

このように本発明では縦溝の側壁の傾斜角度をタイヤ軸方向内側で小さく、タイヤ軸方向外側で大きくし、しかもその傾斜角度を特定範囲に設定しているため、側壁の変形を最小限にとどめ縦溝の容積をほぼ一定に保持することが可能となり、コーナリング時の排水性、制動性、耐摩耗性が総合的に向上する。

なお本発明はタイヤトレッド部がスチールコード等の高弾性繊維コードで補強されたベルト層を

通えたラジアルタイヤに好適に採用されるが、ベルトッドバイアスタイヤ、クロスプライタイヤにも同様に採用することができる。

また本発明は、タイヤ周方向に連続する縦溝を有するいわゆるリブパターンのほか、ブロックパターン、リブーラグパターン、リブーブロックパターンも同様に適用しうる。

4図面の簡単な説明

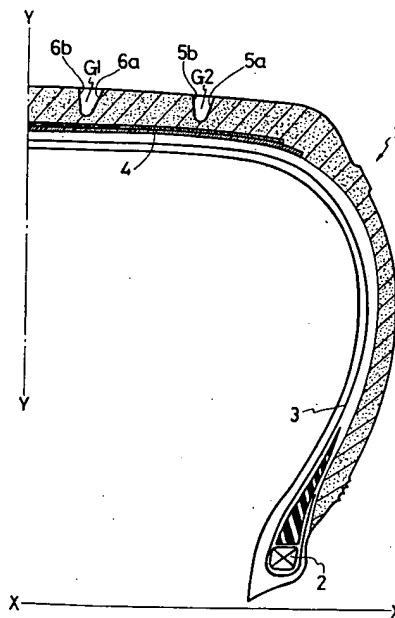
第1図は本発明のタイヤの断面図の右半分、第2図はその縦溝部分の拡大図、第3図は走行時のタイヤの諸面、第4図、第5図、第6図はトレッド部の部分断面図である。

- 1・・・タイヤ、 2・・・ビードコア、
3・・・カーカス、 4・・・ベルト層、
5a, 5b, 6a, 6b・・・側壁、
G1, G2, GA, GB・・・縦溝、

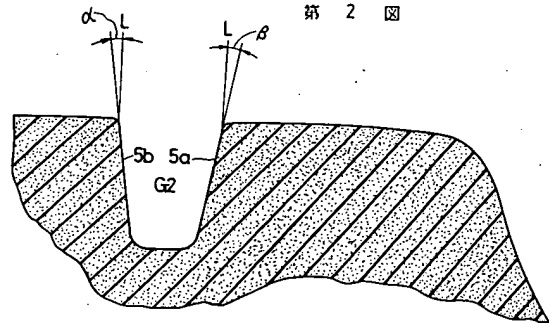
特許出願人 住友ゴム工業株式会社

代理人 弁理士 仲 村 義 平

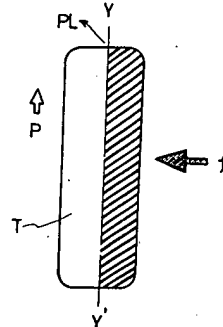
第 1 図



第 2 図



第 3 図



PNEUMATIC TIRE
[Kuki-iri taiya]

Shigeaki Takigawa

UNITED STATES PATENT AND TRADEMARK OFFICE
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(72) Inventor : Shigeaki Takigawa

(71) Applicant : Sumitomo Rubber Industries, Ltd.

(54) PNEUMATIC TIRE

SPECIFICATIONS

1. Title of the Invention

Pneumatic Tire

2. Claims

(1) Pneumatic tire so characterized that it has several longitudinal grooves on the tread surface running continuously in the circumference direction of the tire, at least one longitudinal groove of said longitudinal grooves is formed in its cross-sectional shape as an asymmetrical groove in which angle (β) to the normal line of the outside sidewall tire tread surface in the tire axial direction is greater than angle (α) to the normal line of the inside sidewall tire tread surface in the tire axial direction, and moreover, the above-mentioned angle (β) of the above-mentioned outside sidewall in the tire axial direction is in the range of 10° to 30° .

(2) Pneumatic tire in accordance with Claim No. 1 in which angle (α) to the normal line of the inside sidewall tire tread surface in the tire axial direction is in the range of 0° to 5° .

3. Detailed Specifications

This invention pertains to a pneumatic tire that is improved in drainage, maneuvering stability, and gripping during cornering by making the angle of inclination of the sidewalls of a longitudinal groove on the tire tread surface greater on the outside in the tire axial direction than on the inside in the tire axial direction.

Generally, on tires, to improve drainage and gripping on wet road surfaces, several longitudinal grooves are installed on the tread surface that run continuously in the tire circumference direction. From the standpoint of improving drainage, increasing the width and depth of

longitudinal grooves and increasing the number of grooves are both said to be effective. However, when longitudinal grooves are increased in width and depth, the value of the so-called sea/land ratio of the tread part is increased, and this reduces the toughness of the tread part on the one hand, and reduces maneuvering stability and abrasion resistance on the other. Moreover, the former characteristic is in an antonymous relationship with the latter characteristic. Therefore, previously, the shape of grooves on the tread surface has been designed by considering the balance between these two characteristics, and the width of grooves, depth of grooves, and number of grooves are limited naturally within set ranges. In addition, from the standpoint of diagonal abrasion prevention or beauty of appearance, the cross-sectional shape of longitudinal grooves has been formed such that groove sidewalls are symmetrical to each other. With such previous groove design technology, it becomes difficult to simultaneously improve drainage, maneuvering stability, and abrasion resistance.

Therefore, to resolve the problems described above, the present inventors created a model of the deformation behavior of a tread surface during tire use and performed detailed study of the relationship of this deformation state to the cross-sectional shape of grooves. By optimizing the cross-sectional shape of grooves on the basis of their findings, they were able to achieve improvement in maneuvering stability and abrasion resistance without sacrificing drainage.

This invention is a pneumatic tire that is so characterized that it has several longitudinal grooves on the tread surface running continuously in the circumference direction of the tire, at least one longitudinal groove of said longitudinal grooves is formed in its cross-

sectional shape as an asymmetrical groove in which angle (β) to the normal line of the outside sidewall tire tread surface in the tire axial direction is greater than angle (α) to the normal line of the inside sidewall tire tread surface in the tire axial direction, and moreover, the above-mentioned angle (β) of the above-mentioned outside sidewall in the tire axial direction is in the range of 10° to 30° .

Below, an embodiment of this invention is explained according to the appended figures. Figure 1 is the right half of a schematic cross section of a pneumatic tire of this invention that has a radial structure. Figure 2 is an enlargement of the longitudinal grooves shown in Figure 1. In Figure 1, line X-X is the tire axis and perpendicular line Y-Y is the tire equator.

Pneumatic tire (1) of this invention has two rubber beads (2) and carcass (3) that is folded back around this from the inside to the outside, and belt layer (4) installed on the outside of the crown part of this carcass. In addition, two longitudinal grooves (G1) and (G2) are installed on the tire tread surface that run continuously in the tire circumference direction. In addition, sidewalls (5a) and (5b) of one longitudinal groove (G2) are inclined to form set angles (α) and (β) relative to normal line (L) of the tire tread surface. In this case, these form an asymmetrical groove in which angle (β) of sidewall (5a) on the outside in the tire axial direction inclines at a greater angle than angle (α) of sidewall (5b) on the inside in the tire axial direction. To accomplish this, sidewalls (5a) and (5b) can be formed at a roughly constant inclination in the tire circumference direction, but such that the angle of inclination changes in the outer circumference direction of the tire. In addition, the above-mentioned angle (β) of the sidewall on

the outside in the tire axial direction is set in a range of 10° to 30° . By forming the cross-sectional shape of the longitudinal groove as described above, the toughness of the tread part during tire use is improved. As a result, the amount of deformation of the longitudinal groove can be decreased and a stable longitudinal groove volume is maintained. Together with maintaining drainage, this also improves maneuvering stability. When a model of the deformation behavior of the tread surface during tire use was created, this result could be confirmed from the relationship of this deformation state to the cross-sectional shape of the groove. That is, in Figure 3, when cornering to the left (PL direction) is performed while running tire (T) in direction (p), the tread part on the right half (shaded part) of the tire is subject to deformation in direction (f). To explain this using the right half tread part cross section shown in Figure 4, when not under a load, tread surface perimeter line (OL) is deformed during cornering, and this largely determines the groove width of longitudinal grooves (Ga) and (Gb). As a result, earth contact characteristics are reduced. For example, because the groove width of longitudinal groove (Ga) is deformed during cornering such that it contracts from (W1) to (W2), the volume of the longitudinal groove is decreased and drainage is reduced. Therefore, it is desirable to decrease the amount of change in the groove width of longitudinal grooves as much as possible. However, when the relationship was studied between change in this groove width and the angles of longitudinal groove sidewalls, it was found that change in groove width was reduced as longitudinal groove sidewall angle (β) on the outside in the tire axial direction was increased. Furthermore, the rate of effect of this deformation on sidewall angle was less for

sidewall (Ga1) on the inside in the tire axial direction than for sidewall (Ga2) on the outside in the tire axial direction.

For example, when force acts in direction (f) on the tread parts shown in Figures 5 and 6, the two sidewalls of each of longitudinal grooves (GA) and (GB) differ in amount of deformation according to their angles of inclination as shown in Table 1. In Figure 5, ($\alpha 1$) and ($\alpha 2$) are 5° and ($\beta 1$) and ($\beta 2$) are 30° [Translator's Note: sic; " 30° " should read " 5° "], and in Figure 6, ($\alpha 1$) and ($\alpha 2$) are 5° and ($\beta 1$) and ($\beta 2$) are 30° . From the table, it can be seen that by making the sidewall on the outside in the tire axial direction greater than the sidewall on the inside, decrease in groove width can be greatly reduced.

Figure 1

		Asymmetric Groove (Figure 5)		Symmetric Groove (Figure 6)	
		GA	GB	GC	GD
deformation of side wall	①	0.77	0.84	0.71	0.82
	②	1.86	1.86	1.46	1.46
decrease in groove width	①	1.09	1.02	0.75	0.64
	②				

Therefore, because increasing the angle of inclination of longitudinal grooves decreases the area of earth contact of the tread part and reduces drainage effect and abrasion resistance, these angles of inclination are subject to natural limits. In this invention, angles ($\alpha 1$) and ($\alpha 2$) to the normal line of the tire tread surface of sidewalls (5b) and (6b) on the inside in the tire axial direction are restricted to the range of 0° to 5° , and angles ($\beta 1$) and ($\beta 2$) to the normal line of

the tire tread surface of sidewalls (5a) and (6a) on the outside in the tire axial direction are restricted to the range of 10° to 30° . Also, ideally, the difference between angle (α) on the inside in the tire axial direction and angle (β) on the outside in the tire axial direction is restricted to a range of 5° to 20° .

Thus, in this invention, because the angle of inclination of the sidewall of longitudinal grooves is smaller on the inside in the tire axial direction and larger on the outside in the tire axial direction, and moreover, these angles of inclination are restricted to specific ranges, deformation of sidewalls can be kept to a minimum, the volume of longitudinal grooves can be kept roughly constant, and the properties of drainage, maneuvering stability, and gripping during cornering are improved overall.

Moreover, this invention ideally is applied to radial tires in which the tire tread part has a belt layer that is reinforced by highly elastic fiber cords such as steel cords. However, this invention also can be applied in the same way to belted bias tires or cross-ply tires.

Also, besides tires that have longitudinal grooves in a so-called rib pattern running in the tire circumference direction, this invention also can be applied in the same way to tires that have longitudinal grooves in a block pattern, rib-lug pattern, or rib-block pattern.

4. Key to Figures

Figure 1 is the right half of a schematic cross section of a tire of this invention. Figure 2 is an enlargement of the longitudinal groove part of Figure 1. Figure 3 is a cross section of the tire tread surface during tire use, and Figures 4, 5, and 6 are partial cross sections of the tread part.

- | | |
|---|-------------------|
| 1 ... tire | 2 ... rubber bead |
| 3 ... carcass | 4 ... belt layer |
| 5a, 5b, 6a, 6b ... sidewalls | |
| G1, G2, GA, GB ... longitudinal grooves | |

Figure 1

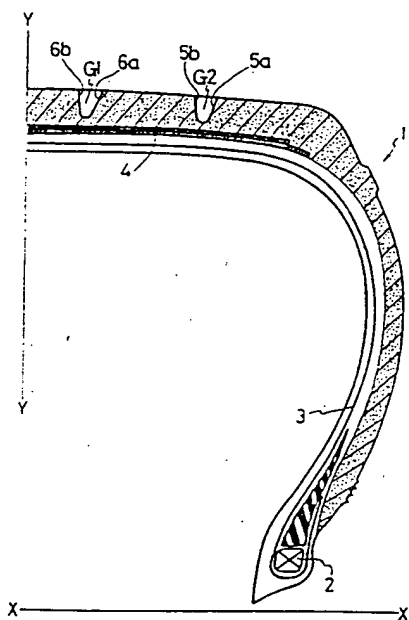


Figure 2

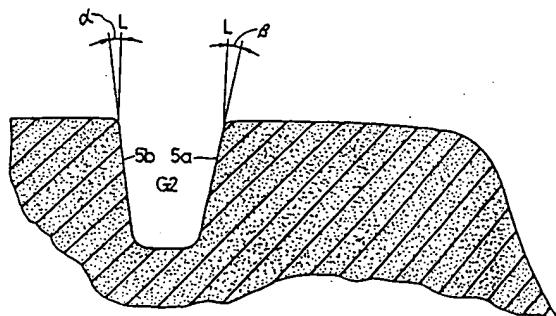


Figure 3

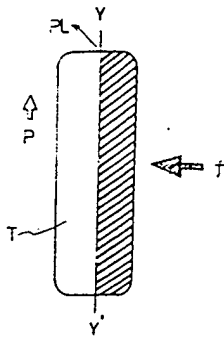


Figure 4

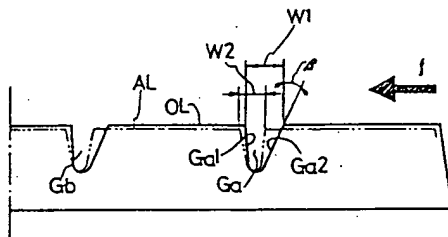


Figure 5

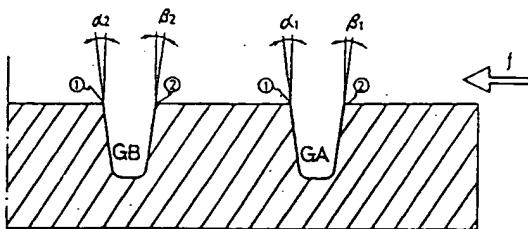


Figure 6

